Explorer's Guide

Got Blood?

There's A, B, AB, and O. How can you tell which is which?

Would you like to save someone's life some day by donating some of your blood? If you donate blood, a test will be done to determine what "type" it is. Find out what blood typing is all about.

Things You Will Need

- ▲ 3-oz paper cups
- ▲ 8 toothpicks
- ▲ marker for labeling cups
- ▲ 4 blood-typing stations with simulated blood and testing fluids
- ▲ paper for recording observations

To Do and Notice

This activity works best with a facilitator.

There are four blood-typing stations set up in the room. You will go to each one and test the "blood" there with the two testing fluids provided. You will observe the reaction of each test, and use these observations to determine the blood type at each station. Leave all of the materials at each station.

❶ At your first station, place 3 mL of the "blood" into a container. Label the container with the station number and "anti-A."

❷ Add 10 drops of the anti-A testing fluid to the blood and mix with a toothpick. This fluid simulates an anti-A antiserum. When real blood is typed, anti-A antiserum reacts with markers called A antigens on the surface of the red blood cells in the blood.

❸ Observe and record what happens. If the blood clumps, as shown in Figure 1A, the reaction is positive. You can record a positive reaction with a plus sign (+). If nothing happens to the blood, as shown in Figure 1B, the reaction is negative. This reaction can be recorded with a minus sign (–).

❹ Place another 3 mL of the same blood into another container. Label the container with the station number and "anti-B."

❺ Add 10 drops of the anti-B testing fluid to the blood and mix with a fresh toothpick. This fluid simulates an anti-B antiserum, which is used in blood typing to detect the presence of B antigens on the surface of the red blood cells in the blood.

❻ Observe and record what happens.

❼ Repeat the procedure at each of the other three stations. Record your results each time.

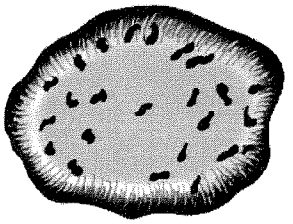

Figure 1A: Positive reaction

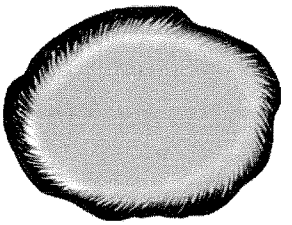

Figure 1B: Negative reaction

Interpreting Your Observations

Use the information below to determine which blood type is being simulated at each station.

Table 1

Antigens on Red Blood Cells*	Blood Type
A	A
B	B
both A and B	AB
neither A nor B	O

*A positive reaction to the anti-A antiserum means the blood contains the A antigen; a positive reaction to the anti-B antiserum means the blood contains the B antigen.

Facilitator's Guide

Got Blood?

Materials

For the whole group

- about 250 mL of nonfat milk
- about 250 mL of water
- red and green food coloring
- 100 mL of white vinegar
- 100 mL water
- 12 flasks or containers to hold "blood" and "antisera"
- 4 droppers, with 1-mL calibrations
- 8 droppers (calibrations unnecessary)
- string to attach droppers to containers
- tape for labeling containers
- cocoa powder (optional)

for each pair or small group

- 8 3-oz paper cups
- 8 toothpicks
- marker for labeling
- paper for recording observations

Management

- Amount of time for the activity: 30 minutes
- Preparation time: 30–45 minutes
- Group size: 2, 3, or 4

Preparation and Setup

Activity Overview

Use simulated blood and antisera to model the immune responses used to determine ABO blood group.

Concepts

› Antigens on the surfaces of our cells help our immune systems distinguish between cells that belong in the body and cells that don't.

› The presence or absence of two antigens, A and B, on red blood cells determines which of the four blood groups, or types, a person's blood belongs to: A, B, AB, or O.

› The immune reaction of anti-A and anti-B antibodies with their antigens is used to "type" a sample of blood.

Preparation

❶ To make enough simulated blood for 15 groups: Dilute nonfat milk by one-half (i.e., 250 mL milk and 250 mL water). Mix thoroughly. Add red and green food coloring. (We recommend about 1 tablespoon red and 5 drops green. Add 3 tablespoons cocoa powder and heat gently for a darker color, if you wish.) Refrigerate until use.

❷ Set up the blood-typing stations. Each lab station will have the same simulated "blood" but a different set of simulated antisera, as shown in Table 2 on the next page. When the antiserum is vinegar, it will produce a simulated positive reaction; when it is water, the reaction will be negative. It is critical that the antisera listed for each blood group be kept with that blood group, or the activity will not work properly. Set up the stations as far apart as possible to minimize the chances of mixing up the antisera.

Tips!

- Put the simulated antisera into small dropper bottles for easier use. It will keep indefinitely.
- Follow this activity with the closely related activity "Mother and Child Reunion" (page 47). Since similar materials are used in both activities, you can save time in preparation. Moreover, this activity provides excellent background for "Mother and Child Reunion." If you plan to do both activities, prepare 1100 mL of simulated blood by diluting 550 mL of milk with 550 mL of water and coloring it with 2 tablespoons of red food coloring and 10 drops of green.

a. Put about 120 mL of simulated blood in each of four containers.

b. Put about 25 mL of vinegar in each of four containers, and 25 mL of water in another four.

c. At station 1, place a container of simulated blood labeled "1," a container of vinegar labeled "anti-A," and a container of water labeled "anti-B."

d. Set up the other three stations with the appropriately labeled blood and antisera containers, as shown in Table 2.

e. Attach calibrated droppers to the blood containers and uncalibrated droppers to the antisera containers with string and tape. Do not reveal which blood group will be simulated at each station.

Table 2

Station	Simulated Antisera	Simulated Blood Type
1	anti-A = vinegar anti-B = water	A
2	anti-A = water anti-B = vinegar	B
3	anti-A = vinegar anti-B = vinegar	AB
4	anti-A = water anti-B = water	O

Questions for Getting Started

› Do you know what your blood type is? Why might you need to know your blood type?

› What is a blood transfusion? Why might someone need to have one?

After the Exploration

Expected Results

Table 3 summarizes the results that should be obtained at each station.

Table 3

	Station 1	Station 2	Station 3	Station 4
Reaction to anti-A	+	–	+	–
Reaction to anti-B	–	+	+	–
Blood group	A	B	AB	O

What's Going On?

When the "antiserum" is vinegar, its low pH denatures (unravels the three-dimensional structure of) the proteins in the milk, causing a visible clumping. In real blood, when a positive antibody–antigen reaction occurs, antibodies bind to many of the antigens on the red blood cell surface, forming a network that looks like clumps. The antisera at each station are set up to simulate the reactions that would occur with real blood of groups A, B, AB, and O, respectively.

Discussion Questions

❶ Blood type O is called the "universal donor" and type AB is called the "universal recipient" for blood transfusions. Why do you think that this is so?

❷ How might a determination of blood type be used to solve a crime?

Going Further: Ideas for Inquiry

› Learn about blood banking, blood types, blood donation, and the uses of donated blood by doing some research or talking with a staff member at a local blood bank.

› You may have heard of blood types being called "positive" and "negative." These names have to do with the presence or absence of another type of antigen on the surface of red blood cells called the rhesus factor, or Rh factor for short. Find out more about the Rh factor and why it may cause problems during pregnancy.

The Basics and Beyond

Background

Cells in our bodies have markers called antigens on their surfaces. These antigens are part of the body's immune system, which works to recognize cells that belong in the body ("self") and cells that don't ("nonself"). When immune-system cells find a cell with antigens they don't recognize, they produce antibodies that attach to the antigens; this marks the cell for destruction by other immune-system cells.

Two different antigens that can be present on the surface of red blood cells are the basis for the ABO blood group system, or what is commonly called blood type. Some people have the A antigen on their red blood cells, some have the B antigen, some have both, and some have neither.

The plasma (liquid) portion of each person's blood contains antibodies against the antigens not present on their own red blood cells. If your

red blood cells only have the A antigen, for example, then your plasma has the anti-B antibody. The table below shows which antibodies and antigens are present in each blood group.

Table 4

Group	Antigens	Antibodies
A	A	anti-B
B	B	anti-A
AB	AB	neither
0	neither	both

If the anti-B antibody comes in contact with the B antigen, or the anti-A antibody finds the A antigen, the antibodies bind to their corresponding antigens. The result is a clumping of the red blood cells. If this occurs in a person's body (when they are given the wrong kind of blood), it could be fatal.

But the clumping reaction can also be used to determine the blood group of blood drawn from a person's body. The blood is combined with a liquid called antiserum that contains anti-A antibodies. Then a second sample of the blood is combined with antiserum that contains anti-B antibodies. The resulting clumping or lack of clumping in each test allows the blood to be "typed."

Tidbits

› Antibodies to nonself blood types (those that are not yours) are developed during infancy. This recognition by the body of nonself entities entering the body is mediated by the immune system.

› The immune system will launch an attack against anything it identifies as nonself—a virus, bacterium, parasite, transfused blood, or transplanted organ. This amazing system keeps us healthy, but it also presents challenges to physicians when an organ is transplanted. Then, strong drugs that suppress the immune system are administered until the transplant is accepted by the body.

› Some biotechnology companies are attempting to genetically engineer pigs so that their organs express human antigens on their surfaces. The hope is that pig organ transplants may be readily accepted by the human body and that pigs might provide an unlimited source of organs for transplant.

› Scientists are exploring ways to remove some of a person's stem cells, grow them in the lab, and coax them into developing into specific tissues and organs. If these tissues and organs were transplanted back into the donor, they would be a recognized as "self" and not rejected by the person's immune system.